# Patent Subsidies and Patent Filing in China

## The First Applicant-level Study

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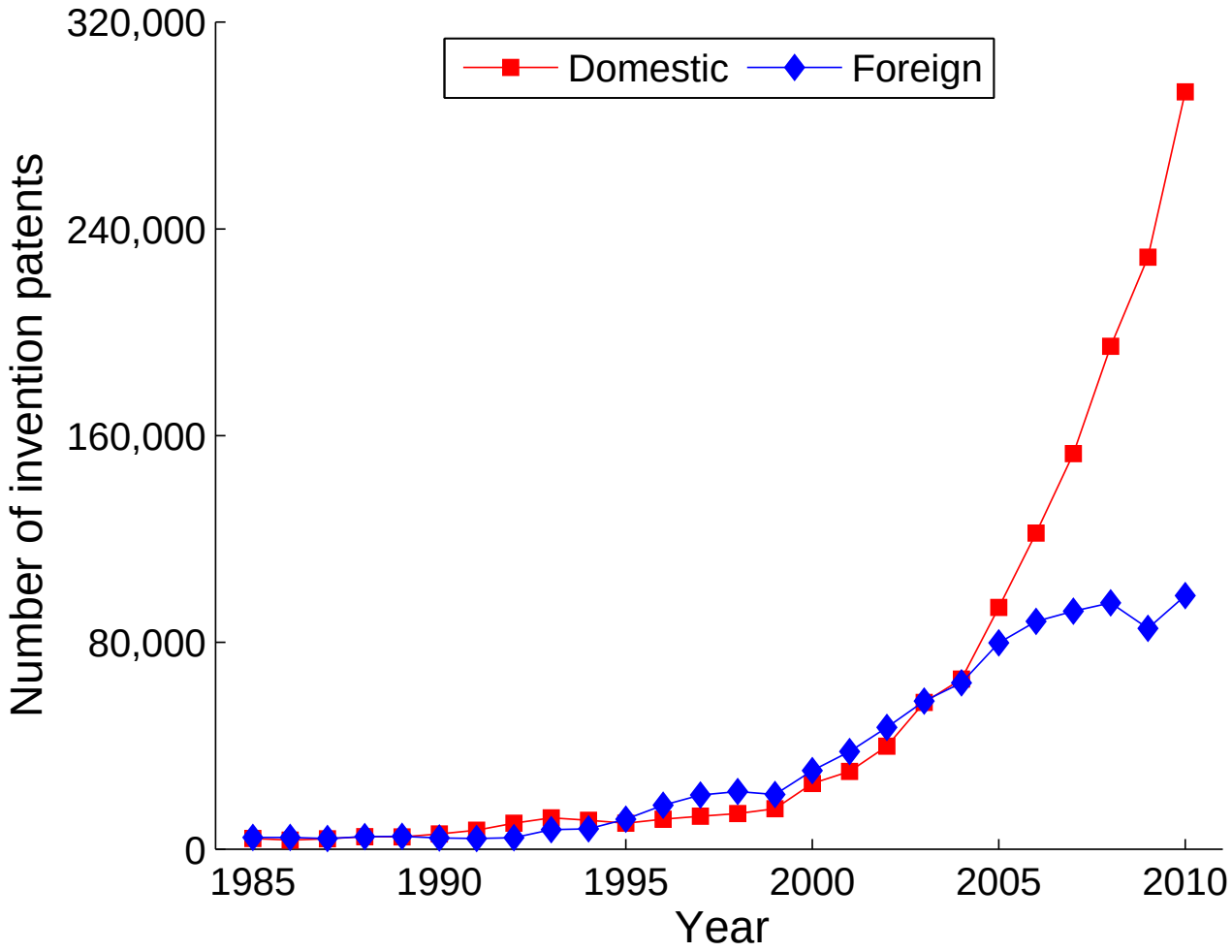
New Perspectives on Innovation and Intellectual Property in China
USPTO-UCSD Workshop, May 19, 2015

# Patent Application Growth at SIPO

## Applications for invention patents: 1985-2010



# What's going on?

- "The leadership in China knows that innovation is its future, ... They are doing everything they can to drive innovation, and China's patent strategy is part of that broader plan."

  *"When innovation, too, is made in China", NYT, January 1st, 2011*

- Such incentives produce results... China's overall patent filings grew by 26% a year between 2003 and 2009...Growth was much slower elsewhere: 6% in America, 5% in South Korea, 4% in Europe and 1% in Japan.

- ...the generosity of China's incentives for patent-filing may make it worthwhile... to patent even worthless ideas. "Patents are easy to file, ... but gems are hard to find in a mountain of junk."

  *"Patents, yes; ideas, maybe?", The Economist, Oct 14th, 2010*

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# Outline

# Outline

# Patent Subsidy Policy in China

## Increase IP awareness; encourage patenting; promote innovation

- Policies at province and city level in China
  - Subsidies for patent filings
  - Reward for patent grants
- Other nations have similar policies for small entities:
  - USA: 50% reduction in filing fees since 1982 (in recent reform, 75% for micro-entities)
  - South Korea: 70% reduction in filing fees
  - Singapore: up to 30,000 SGD

# Outline

# Research Question

What are the effects of patent subsidy on patent filings in China, in terms of both the number and characteristics of patent applications?

# Outline

# A Case Study

- We compare 6 neighboring cities within Suzhou Municipality
- Zhangjiagang, Wujiang, Taicang, Suzhou, Kunshan and Changshu
- After June 2006, Zhangjiagang increased its patent subsidies while the other cities' policies did not change.

# Subsidies for Invention Patents within Suzhou Municipality

| City | June 2004 | June 2006 | December 2007 |
|---|---|---|---|
| Zhangjiagang | 1500[a] | 3000+10000[b] | unchanged until 2010 |
| Wujiang | 2000 | unchanged | unchanged until 2010 |
| Taicang | 4000+5000 | unchanged | unchanged until 2010 |
| Suzhou | 4000 | unchanged | unchanged |
| Kunshan | 4000 | unchanged | unchanged |
| Changshu | 2000 | unchanged | unchanged until April 2008 |

[a] The subsidy is in Chinese Yuan (RMB).

[b] The first number is the subsidy on submission, the second is for granted patents.

# A Difference-in-differences Method

- Treated city: Zhangjiagang
- Control cities: Wujiang, Taicang, Suzhou, Kunshan, Changshu
- July 2004 – June 2006: before the policy change in Zhangjiagang
- July 2006 – December 2007: after the policy change in Zhangjiagang

# Outline

# Data

- We have the published patent application data in these cities from July 2004 to the end of 2007.
- The time unit considered in the study is half a year. Therefore, the observation intervals are 7 half-years.
- We have a panel of 3569 applicants over 7 time periods.

# Outline

- On Dec 23, 2005, the government made some changes in their leadership, and for the first time, a vice director was assigned to be responsible for the “patent department”.
- On Jan 23, 2006, the patent department made an announcement to clarify its duties, which include, among others, drafting and implementing IP policy, building the city as an IP model city, and rolling out the patent subsidy.
- The subsidy increase was announced on June 12, 2006. It seemed to be the result of a leadership reshuffle, which is not likely to be a response to the industry’s need.

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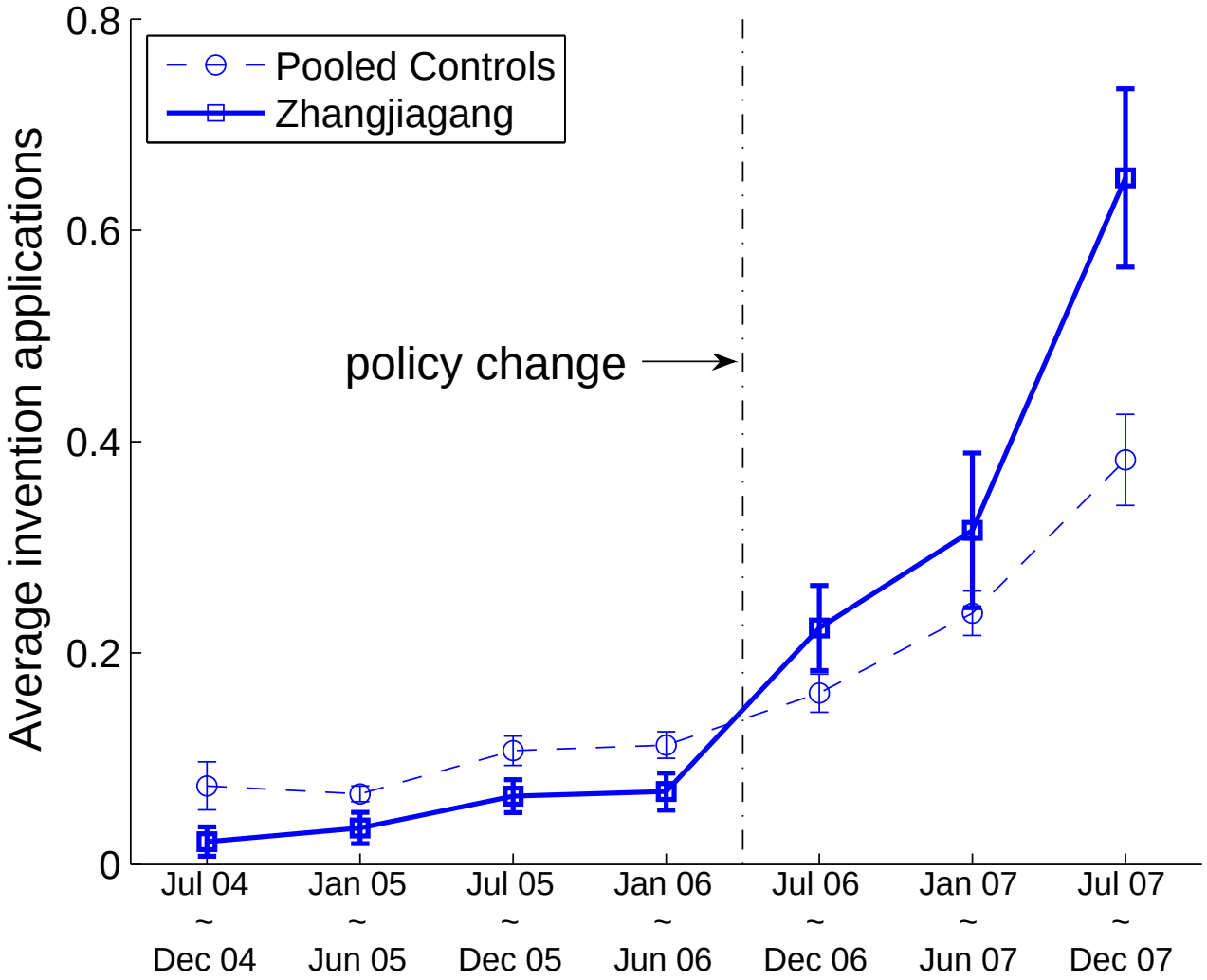
# Outline

# A Graphical View: Invention Patents Filed by Applicants

## Comparison between Zhangjiagang and the pooled control cities



# Outline

- Model:

$$y_{ict} = \beta \cdot x_{ct} + \alpha_c + \lambda_t + \varepsilon_{ict}$$

- $y_{ict}$ **is the number of patent applications by applicant** $i$ **of city** $c$ **in half-year** $t$. The policy dummy variable is $x_{ct}$, $x_{ct} = 1$ for Zhangjiagang after July 2006. The city fixed effect is $\alpha_c$. The half-year time fixed effect is $\lambda_t$.
- Use pair-wise comparison to improve the robustness of the results.
- Use "placebo treatment" to test the validity of controls.

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- Use "placebo treatment" to test the validity of controls.

# Difference-in-differences Results-Patent Applications
## A significant increase in Zhangjiagang after June 2006

$$y_{ict} = \beta \cdot x_{ct} + \alpha_c + \lambda_t + \varepsilon_{ict}$$

| Treated/Control | Taicang | Suzhou | Kunshan | Changshu | Pooled Controls |
|---|---|---|---|---|---|
| **Zhangjiagang** | **0.145**** | **0.196***** | **0.160**** | **0.167***** | **0.179***** |
| | (0.0567) | (0.0523) | (0.0686) | (0.0500) | (0.0471) |
| # of applicants | 744 | 1945 | 1012 | 949 | 3255 |
| # of observations | 5208 | 13615 | 7084 | 6643 | 22785 |
| Taicang | | 0.0514 | 0.0151 | 0.0224 | 0.0379 |
| | | (0.0480) | (0.0655) | (0.0455) | (0.0433) |
| # of applicants | | 1759 | 826 | 763 | 2790 |
| # of observations | | 12313 | 5782 | 5341 | 19530 |
| Suzhou | | | -0.0363 | -0.0290 | -0.0368 |
| | | | (0.0616) | (0.0399) | (0.0396) |
| # of applicants | | | 2027 | 1964 | 2790 |
| # of observations | | | 14189 | 13748 | 19530 |
| Kunshan | | | | 0.00736 | 0.0237 |
| | | | | (0.0597) | (0.0578) |
| # of applicants | | | | 1031 | 2790 |
| # of observations | | | | 7217 | 19530 |
| Changshu | | | | | 0.0141 |
| | | | | | (0.0352) |
| # of applicants | | | | | 2790 |
| # of observations | | | | | 19530 |

Robust standard errors clustered at firm level in parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Treatment estimates

Placebo treatment estimates

# Robustness Checks

| | (1) Firm-fixed effect | (2) Ashenfelter's Dip | (3) Invention Firms Only | (4) Unbalanced Panel |
|---|---|---|---|---|
| $\beta$ | $0.179^{***}$ | $0.215^{***}$ | $0.400^{***}$ | $0.203^{***}$ |
| | (0.0471) | (0.0636) | (0.1066) | (0.0766) |
| Clusters | 3255 | 3255 | 1237 | 1684 |
| $N$ | 22785 | 16275 | 8659 | 9457 |

Robust standard errors clustered at applicant level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(1) Use applicant fixed-effect instead of city fixed-effect.
(2) Omit data half year before and after the policy announcement.
(3) Exclude applicants that didn't make any invention patent applications.
(2) Use only applicants that "exist".

# Difference-in-differences Results-Granted Patents
## No increase in Zhangjiagang after June 2006

$$y_{ict} = \beta \cdot x_{ct} + \alpha_c + \lambda_t + \varepsilon_{ict}$$

| treatcity | vs_taicang | vs_suzhou | vs_kunshan | vs_changshu | vs_other |
|---|---|---|---|---|---|
| Zhangjiagang | 0.228** | -0.0140 | -0.0190 | 0.116 | 0.0278 |
| | (0.106) | (0.0754) | (0.0884) | (0.0900) | (0.0713) |
| # of applicants | 301 | 754 | 342 | 410 | 1237 |
| # of observations | 395 | 1040 | 503 | 554 | 1712 |
| Taicang | | -0.246*** | -0.249** | -0.108 | -0.220*** |
| | | (0.0873) | (0.101) | (0.0998) | (0.0841) |
| # of applicants | | 675 | 263 | 331 | 1047 |
| # of observations | | 915 | 378 | 429 | 1452 |
| Suzhou | | | -0.0105 | 0.112 | 0.0869* |
| | | | (0.0661) | (0.0686) | (0.0507) |
| # of applicants | | | 716 | 784 | 1047 |
| # of observations | | | 1023 | 1074 | 1452 |
| Kunshan | | | | 0.119 | 0.0573 |
| | | | | (0.0833) | (0.0631) |
| # of applicants | | | | 372 | 1047 |
| # of observations | | | | 537 | 1452 |
| Changshu | | | | | -0.0897 |
| | | | | | (0.0652) |
| # of applicants | | | | | 1047 |
| # of observations | | | | | 1452 |

Robust standard errors clustered at firm level in parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Treatment estimates

Placebo treatment estimates

# Outline

# Total Number of Claims per Applicant

- Model:

$$tot_{ict} = \beta \cdot x_{ct} + \alpha_c + \lambda_t + \varepsilon_{ict}$$

- $tot_{ict}$ **is the total number of claims from patent applications filed by applicant** $i$ **of city** $c$ **in half-year** $t$. The policy variable is $x_{ct}$, $x_{ct} = 1$ for Zhangjiagang after July 2006. The city fixed effect is $\alpha_c$. The half-year time fixed effect is $\lambda_t$.
- Use placebo treatment to test the validity of controls & result robustness.

# Total Number of Claims per Applicant
## No significant increase in Zhangjiagang after June 2006

$$tot_{ict} = \beta \cdot x_{ct} + \alpha_c + \lambda_t + \varepsilon_{ict}$$

| Treated/Control | Taicang | Suzhou | Kunshan | Changshu | Pooled Controls |
|---|---|---|---|---|---|
| Zhangjiagang | 0.592 | 0.139 | -1.443 | -0.368 | -0.149 |
| | (0.505) | (0.680) | (1.357) | (0.610) | (0.531) |
| # of applicants | 301 | 754 | 342 | 410 | 1237 |
| # of observations | 2107 | 5278 | 2394 | 2870 | 8659 |
| Taicang | | -0.453 | -2.035 | -0.959 | -0.829 |
| | | (0.656) | (1.346) | (0.585) | (0.534) |
| # of applicants | | 675 | 263 | 331 | 1047 |
| # of observations | | 4725 | 1841 | 2317 | 7329 |
| Suzhou | | | -1.582 | -0.507 | -0.625 |
| | | | (1.418) | (0.740) | (0.736) |
| # of applicants | | | 716 | 784 | 1047 |
| # of observations | | | 5012 | 5488 | 7329 |
| Kunshan | | | | 1.075 | 1.514 |
| | | | | (1.388) | (1.345) |
| # of applicants | | | | 372 | 1047 |
| # of observations | | | | 2604 | 7329 |
| Changshu | | | | | 0.277 |
| | | | | | (0.661) |
| # of applicants | | | | | 1047 |
| # of observations | | | | | 7329 |

Robust standard errors clustered at firm level in parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Treatment estimates

Placebo treatment estimates

# Average Number of Claims per Patent Application
## Significant decrease in Zhangjiagang after June 2006

$$avg_{ict} = \beta \cdot x_{ct} + \alpha_i + \lambda_t + \varepsilon_{ict}$$

| Treated/Control | Taicang | Suzhou | Kunshan | Changshu | Pooled Controls |
|---|---|---|---|---|---|
| **Zhangjiagang** | **-0.942** | **-1.493*** | **-1.431** | **-2.279***** | **-1.493**** |
| | (0.884) | (0.705) | (0.905) | (0.793) | (0.705) |
| # of applicants | 301 | 754 | 342 | 410 | 1237 |
| # of observations | 395 | 1040 | 503 | 554 | 1712 |
| Taicang | | -0.491 | -0.276 | -1.231* | -0.583 |
| | | (0.659) | (0.836) | (0.653) | (0.600) |
| # of applicants | | 675 | 263 | 331 | 1047 |
| # of observations | | 915 | 378 | 429 | 1452 |
| Suzhou | | | -0.130 | -0.825 | -0.351 |
| | | | (0.672) | (0.508) | (0.464) |
| # of applicants | | | 716 | 784 | 1047 |
| # of observations | | | 1023 | 1074 | 1452 |
| Kunshan | | | | -0.881 | -0.0252 |
| | | | | (0.677) | (0.621) |
| # of applicants | | | | 372 | 1047 |
| # of observations | | | | 537 | 1452 |
| Changshu | | | | | 0.898* |
| | | | | | (0.449) |
| # of applicants | | | | | 1047 |
| # of observations | | | | | 1452 |

Robust standard errors clustered at firm level in parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Treatment estimates

Placebo treatment estimates

# Average Number of Claims per Granted Patent
## Significant decrease in Zhangjiagang after June 2006

$$avg_{ict} = \beta \cdot x_{ct} + \alpha_i + \lambda_t + \varepsilon_{ict}$$

| Treated/Control | Taicang | Suzhou | Kunshan | Changshu | Pooled Controls |
|---|---|---|---|---|---|
| **Zhangjiagang** | **-2.239** | **-2.545*** | -1.904 | **-3.481**** | **-2.544*** |
| | (1.599) | (1.468) | (1.693) | (1.495) | (1.436) |
| # of applicants | 143 | 417 | 160 | 222 | 714 |
| # of observations | 183 | 572 | 234 | 298 | 978 |
| Taicang | | -0.432 | 0.421 | -1.173 | -0.427 |
| | | (0.835) | (1.042) | (0.787) | (0.740) |
| # of applicants | | 408 | 151 | 213 | 638 |
| # of observations | | 549 | 211 | 275 | 875 |
| Suzhou | | | 0.486 | -0.721 | -0.143 |
| | | | (0.860) | (0.654) | (0.601) |
| # of applicants | | | 425 | 487 | 638 |
| # of observations | | | 600 | 664 | 875 |
| Kunshan | | | | -1.417* | -0.617 |
| | | | | (0.821) | (0.777) |
| # of applicants | | | | 230 | 638 |
| # of observations | | | | 326 | 875 |
| Changshu | | | | | 0.916 |
| | | | | | (0.560) |
| # of applicants | | | | | 638 |
| # of observations | | | | | 875 |

Robust standard errors clustered at firm level in parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Treatment estimates

Placebo treatment estimates

# Average Number of Forward Citations per Year per Granted Patent
## No change in Zhangjiagang after June 2006

$$avg_{ict} = \beta \cdot x_{ct} + \alpha_i + \lambda_t + \varepsilon_{ict}$$

| Treated/Control | Taicang | Suzhou | Kunshan | Changshu | Pooled Controls |
|---|---|---|---|---|---|
| Zhangjiagang | 0.104 | 0.0170 | 0.0148 | 0.116* | 0.0411 |
| | (0.0678) | (0.0490) | (0.0532) | (0.0700) | (0.0466) |
| # of applicants | 143 | 417 | 160 | 222 | 714 |
| # of observations | 183 | 572 | 234 | 298 | 978 |
| Taicang | | -0.0710 | -0.0781 | 0.0214 | -0.0537 |
| | | (0.0560) | (0.0559) | (0.0744) | (0.0545) |
| # of applicants | | 408 | 151 | 213 | 638 |
| # of observations | | 549 | 211 | 275 | 875 |
| Suzhou | | | 0.0235 | 0.0888 | 0.0687* |
| | | | (0.0385) | (0.0572) | (0.0365) |
| # of applicants | | | 425 | 487 | 638 |
| # of observations | | | 600 | 664 | 875 |
| Kunshan | | | | 0.0877 | 0.00559 |
| | | | | (0.0651) | (0.0370) |
| # of applicants | | | | 230 | 638 |
| # of observations | | | | 326 | 875 |
| Changshu | | | | | -0.0815 |
| | | | | | (0.0545) |
| # of applicants | | | | | 638 |
| # of observations | | | | | 875 |

Robust standard errors clustered at firm level in parentheses
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Placebo treatment estimates

# Outline

# Main Results

We evaluate the effectiveness of the patent subsidy policies in China by a case study in Suzhou Municipality, where the subsidy policies resemble many other regions of China.

- We find a significant increase in the number of invention patent applications from innovators in Zhangjiagang.
- The grant rate of patent applications from Zhangjiagang did not drop.
- The total number of claims for each applicant did not increase.
- The increase in applications was matched by a decrease in claims/application.

# Outline

# Implications

- We do not find the policy to be effective:
  - It induced patentees to break up applications to qualify for more rewards.
  - Implications for other patenting systems (for example, fee reduction for small entities in US).
- The lack of increased number of claims suggests that innovators in Zhangjiagang faced no financial constraints in patenting before the subsidy increase.
  - Necessity of local patent subsidies in other economically developed regions in China?
- A patent subsidy scheme that contracts on patent applications or granted patents may not guarantee an increase in the total amount of “effective” innovation.

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  - Necessity of local patent subsidies in other economically developed regions in China?
- A patent subsidy scheme that contracts on patent applications or granted patents may not guarantee an increase in the total amount of “effective” innovation.

# China's Indigenous Innovation Policies

- Medium to Long Term Plan for the Development of Science and Technology (Jan, 2006)
- Measures to promote Chinese IP and innovation capacity
  - Government procurement policy
  - Tax incentives and financial support for R&D and patenting
  - China-specific technical standards
  - Enforcement of Anti-monopoly Act

# Patent Fees

| Type | Application | Examination | Attorney fee | Maintenance/year |
|---|---|---|---|---|
| Invention | 950[a] | 2500 | $\geq$4000[b] | 900-8000[c] |
| Utility Model | 500 | N/A | $\geq$2500 | 600-2000 |
| Design | 500 | N/A | $\geq$1500 | 600-2000 |

[a] The fee is in Chinese Yuan (RMB).
[b] The exact agency fee depends on patents and agencies.
[c] The maintenance fee increases incrementally.

# Parallel Trend Assumption

- In order to estimate the impact of a policy using the diff-in-diffs method, we need the so-called “parallel trend assumption” to hold.
- In the absence of a policy change, the period-specific unobservables exhibit parallel trend between the treated and control units.
- Use the two years data before the policy change to test whether a linear time trend interacted with a dummy for being the treated city is significant.

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# Test of the Parallel Trend Assumption

- Model:
  $y_{ict} = \gamma \cdot t \cdot I_{Zhangjiagang} + \alpha_c + \eta \cdot t + \varepsilon_{ict}$
- Results:

| | Changshu | Kunshan | Suzhou | Taicang | Wujiang | Pooled (w/o Wujiang) |
|---|---|---|---|---|---|---|
| $\gamma$ | -0.0018 | 0.0004 | 0.0057 | -0.0125 | -0.0408** | 0.0015 |
| | (0.0095) | (0.0112) | (0.0162) | (0.0122) | (0.0175) | (0.0108) |

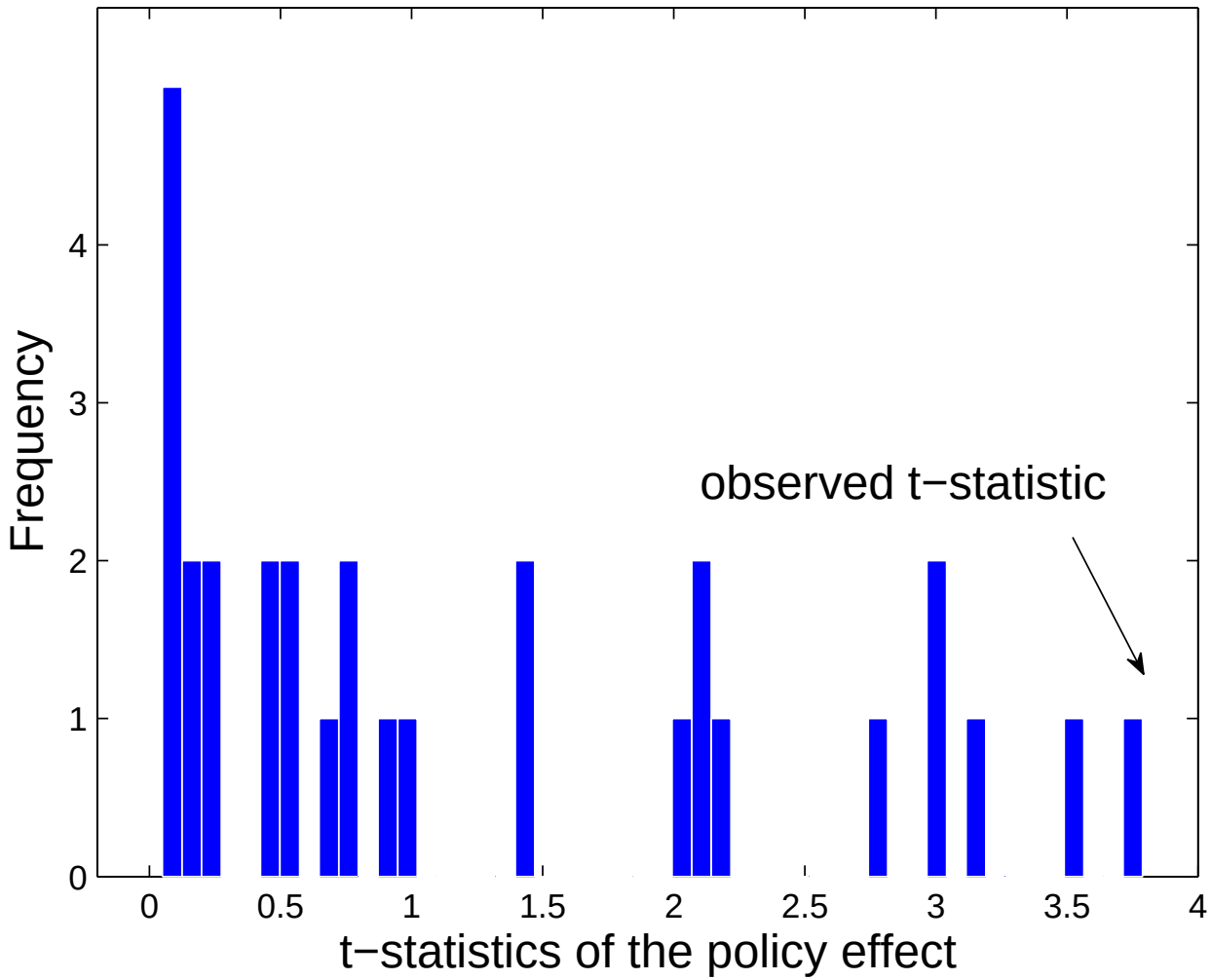
Robust standard errors clustered at applicant level in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

# Summary Statistics
## Comparison of average invention applications before and after the policy change

| City | Before June 2006 | After June 2006 | # of applicants |
|---|---|---|---|
| Changshu | 0.24 (0.04) | 0.72 (0.08) | 484 |
| Kunshan | 0.37 (0.07) | 0.84 (0.17) | 547 |
| Suzhou | 0.43 (0.06) | 0.78 (0.10) | 1480 |
| Taicang | 0.19 (0.04) | 0.76 (0.11) | 279 |
| Wujiang | 0.43 (0.07) | 1.37 (0.36) | 314 |
| **Zhangjiagang** | **0.19 (0.04)** | **1.19 (0.13)** | **465** |

Standard errors are reported in parentheses.

- Average the data at city-by-treatment cells, effectively collapsing the data into 10 cells.
- calculate the change in average applications (per applicant per half-year) for each city.
- regress these differences on a dummy for being the treated city.
- t-statistic from this regression is distributed asymptotically as $t_{c-2}$.
- The estimated t-statistic from this method of 6.91. With 3 degrees of freedom, p-value is 0.0062.


Frequency
0
1
2
3
4
0
0.5
1
1.5
2
2.5
3
3.5
4
observed t−statistic
t−statistics of the policy effect

- Model:

$$g_{ict} = \beta \cdot x_{ct} + T_i + \alpha_c + \lambda_t + \varepsilon_{ict}$$

- $g_{ict}$ **is a dummy indicating the grant of the patent application** $i$ **from city** $c$ **in half-year** $t$. The policy variable is $x_{ct}$, $x_{ct} = 1$ for Zhangjiagang after July 2006. $T_i$ is the technology fixed effect. The city fixed effect is $\alpha_c$. The half-year time fixed effect is $\lambda_t$.
- Use placebo treatment to test the validity of controls & result robustness.

# Grant Rate

## No significant change in Zhangjiagang after June 2006

$$g_{ict} = \beta \cdot x_{ct} + T_i + \alpha_c + \lambda_t + \varepsilon_{ict}$$

| Treated/Control | Taicang | Suzhou | Kunshan | Changshu | Pooled Controls |
|---|---|---|---|---|---|
| Zhangjiagang | 0.286*** | 0.0399 | -0.0339 | 0.0469 | 0.0539 |
| | (0.0732) | (0.0762) | (0.0928) | (0.0824) | (0.0716) |
| # of tech class | 28 | 31 | 30 | 28 | 31 |
| # of observations | 904 | 2434 | 1301 | 1105 | 3821 |
| Taicang | | -0.238** | -0.209 | -0.211** | -0.217** |
| | | (0.105) | (0.124) | (0.0995) | (0.103) |
| # of tech class | | 31 | 30 | 28 | 31 |
| # of observations | | 2056 | 923 | 727 | 3180 |
| Suzhou | | | -0.0180 | 0.0532 | 0.0493 |
| | | | (0.0708) | (0.0559) | (0.0507) |
| # of tech class | | | 31 | 31 | 31 |
| # of observations | | | 2453 | 2257 | 3180 |
| Kunshan | | | | 0.0390 | 0.0328 |
| | | | | (0.0860) | (0.0724) |
| # of tech class | | | | 30 | 31 |
| # of observations | | | | 1124 | 3180 |
| Changshu | | | | | -0.0378 |
| | | | | | (0.0556) |
| # of tech class | | | | | 31 |
| # of observations | | | | | 3180 |

Robust standard errors clustered at technology class level in parentheses

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Treatment estimates

Placebo treatment estimates